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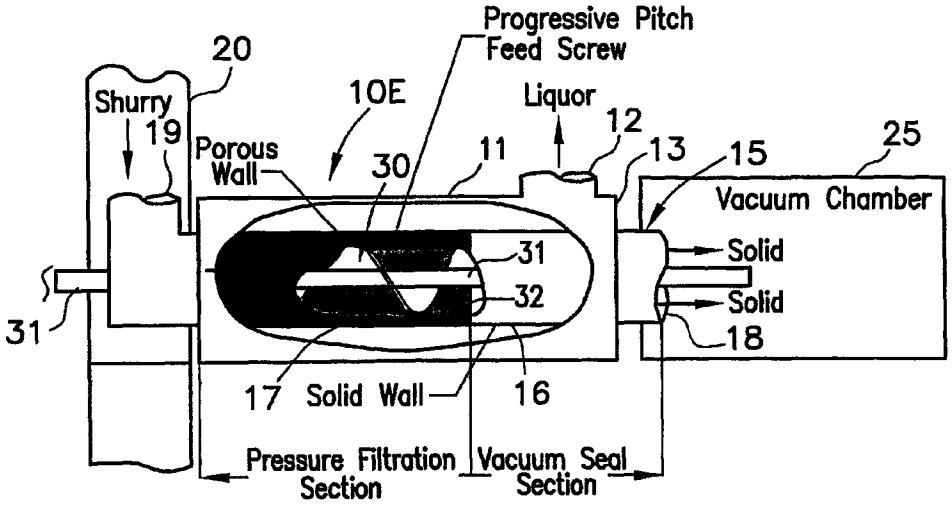
(54) Title: FILTER EXTRACTION MECHANISM



(57) Abstract: A transfer mechanism between a first vessel containing a slurry of liquid and solids and a second vessel with at least one of said first and second vessels being under a protective atmosphere and/or vacuum. There is a housing in communication with the first and second vessels with a screw having at least one helical thread along the longitudinal shank within the housing for transferring material between vessels. The slurry entering the housing from the first vessel has the solids therein concentrated as the slurry is transported toward the second vessel while liquid is expressed from the slurry until the concentrated solids form a plug isolating the two second vessels as solids discharge into the second vessel.

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FILTER EXTRACTION MECHANISM

RELATED APPLICATIONS

This application, pursuant to 37 C.F.R. 1.78(c), claims priority based on non-provisional application Serial No. 10/692,096 filed October 22, 2003, which application according to 35 U.S.C. §365(c), is a continuation-in-part of PCT application serial no. PCT/US03/27647, filed September 3, 2003, which pursuant to 35 U.S.C. 119(e), claims the priority based on Provisional Application Serial No. 60/408,919 filed September 7, 2002.

BACKGROUND OF THE INVENTION

This invention relates to the Armstrong process as described in 5,779,761, 5,958,106 and 6,409,797, the disclosures of each of which is incorporated herein by reference. In the practice of the invention disclosed in the above referenced patents, there is produced in the reaction chamber a slurry consisting of excess reductant metal, salt particles produced and elemental material or alloy particles or powder produced. This slurry is thereafter treated by a variety of methods. However, all of the methods have in common the separation of excess liquid metal from the slurry and thereafter separating the remaining liquid metal and the produced salt from the desired product which is the elemental material or alloy. In the particular example disclosed in the three referenced patents, liquid sodium is used as a reductant for titanium tetrachloride to produce titanium powder.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a transfer mechanism and method for transferring a slurry of liquid and particles between two vessels or containers, at least one of which is under vacuum or inert atmosphere.

Yet another object of the present invention is to provide a transfer mechanism of the type set forth for the Armstrong Process in order to transfer slurry from an inerted vessel or container to a vacuum or inerted chamber for further processing wherein a plug established in the transfer mechanism isolating the vessels or containers.

Yet another object of the present invention is to provide a transfer mechanism between a first vessel containing a slurry of liquid and solids and a second vessel with at least one of the first and second vessels being under a protective atmosphere and/or vacuum, comprising a housing in communication with the first and the second vessels, a screw having at least one helical thread along a longitudinal shank within the housing for transferring material from the first vessel to the second vessel, the screw and the housing cooperating to compress the slurry, whereby slurry entering the housing from the first vessel has the solids therein concentrated as the slurry is transported by the screw toward the second vessel while liquid is expressed from the slurry as the solids are concentrated until the concentrated solids form a plug isolating the second vessel from the first vessel while solids discharge into the second vessel.

A further object of the invention is to provide a transfer mechanism between a first vessel containing a slurry of liquid alkali or alkaline earth metal or mixtures thereof and metal or alloy or ceramic particles and halide salt particles and a second vessel with at least one of the first and second vessels having a protective atmosphere and/or

vacuum therein, comprising a housing in communication with the first and the second vessels, a screw having at least one helical thread along a longitudinal shank within the housing for transferring material from the first vessel to the second vessel, the screw and the housing cooperating to increase the concentration of solids in the slurry between the first and the second vessels until the concentrated particles form a plug isolating the second vessel and the protective atmosphere or vacuum therein from the first vessel and the protective atmosphere or vacuum therein while solids discharge into the second vessel.

A final object of the present invention is to provide a method of concentrating and transferring a slurry of a liquid and solids from one container to another while isolating the environments within the containers from each other, comprising providing communication between the containers, transporting slurry from one container toward another container while expressing liquid from the slurry thereby increasing the solids concentration thereof until a plug is formed between two containers isolating same while solids from the plug are transferred to the another container.

The invention consists of certain novel features and a combination of parts hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the details may be made without departing from the spirit, or sacrificing any of the advantage of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of facilitating an understanding of the invention, there is illustrated in the accompanying drawings a preferred embodiment thereof, from an

inspection of which, when considered in connection with the following description, the invention, its construction and operation, and many of its advantages should be readily understood and appreciated.

FIGURE 1 is a schematic illustration showing the two vessels and an embodiment of the transfer mechanism therebetween;

FIG. 2 is a schematic illustration of an alternate embodiment of the present invention;

FIG. 3 is a schematic illustration of yet another embodiment of the present invention; and

FIG. 4 is a schematic illustration of a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 1 of the drawings, there is shown a transfer mechanism 10 which includes a double walled conduit including an outer conduit wall 11 having a liquid outlet 12 and end walls 13, the wall 11 being preferably but not necessarily cylindrical. Interior of the cylindrical wall 11 is an inner tube or conduit 15 having a portion 16 which is solid and a portion 17 which is apertured and may be a mesh of any suitable size. The inner tube or conduit 15 may either be cylindrical as illustrated in Fig. 1 or conical as will be explained, the inner conduit 15 has a discharge end 18 thereof which opens into a vacuum chamber 25 and has an inlet end 19 thereof which opens into a container or vessel 20 in communication with the reactor as illustrated in the Armstrong patents previously referenced and incorporated herein.

A feed screw 30 is positioned within the inner conduit 15 and includes a rotatable

shank 31 having a helical thread 32 positioned on the shank 31 as is well known in the art. The thread 32 may have a constant or a variable pitch. The pitch is the distance between adjacent threads and the variable pitch may preferably be a progressive pitch in which the pitch decreases from the vessel 20 toward the container or vessel 25, for a purpose hereinafter described.

In the preferred but not limiting embodiment of the present invention, the transfer mechanism 10 is used in conjunction with a material made by the Armstrong Process. More particularly, for purposes of illustration only, the slurry discussed herein will be a combination of liquid sodium, sodium chloride particles and particles of titanium and/or a titanium alloy. As set forth in the Armstrong patents, a variety of metal and non-metal products may be made thereby and it is intended that the present invention not be limited to any particular product made by the Armstrong Process and certainly not limited to the preferred product described herein.

In any event, the vessel or container 20 preferably operated under an inert atmosphere or under vacuum has therein a slurry of the particles previously described and as the slurry enters the portion 19 of the inner conduit or tube 15 and the feed screw 30 is rotated as illustrated in the drawings by rotation of the shank 31, the slurry is moved along the feed screw from left to right as illustrated in Fig. 1. Because of the progressive pitch of the feed screw 30 in Fig. 1, that is the threads 32 thereof are closer together so that the pitch decreases from left to right, the solid material is concentrated as it is moved from the container or vessel 20 to the container or vessel 25. Moreover, because the portion 17 of the conduit or tube 15 is apertured or porous, liquid sodium drains therethrough and passes out of the outlet 12 for further processing. Therefore,

the slurry as it is transported from container or vessel 20 to container or vessel 25 becomes more concentrated as liquid is drained therefrom and the density increases as the pitch between the adjacent threads diminishes.

Another way to express what occurs is that the volume between adjacent threads and the wall of the cylinder or tube 16 diminishes as material is moved by the feed screw 30 from container or vessel 20 to container or vessel 25. By the time the slurry is concentrated and reaches the portion 16, the solid portion 16 of the inner tube or conduit 15, a seal or plug is established between the vessel 25 and the vessel 20 which houses the slurry from the reactor thereby isolating the two vessels and the respective environments therein, one from the other. By isolating, we mean nearly complete separation of the two environments, not necessarily perfect separation, although perfect is desirable. The formation of a seal by the transfer mechanism 10 is a critical aspect of the present invention because separation of liquid sodium and salt from the desired particles of the ceramic or metal alloy, as described in the Armstrong patents may include distillation in a vacuum chamber or a vessel 25 or removal of the liquid metal by vaporization with a hot inert sweep gas and the Armstrong reactor itself may be an inerted vessel such as with argon. Accordingly, it is important for a seal or plug to be formed between the two containers or vessels in order to permit continuous operation between the two vessels without the necessity of shutting down one of the vessels during transfer or destroying the protective atmosphere in the vessel 20 or the vacuum or protective atmosphere in vessel 25.

Referring to Figs. 2 and 3, there are disclosed alternate embodiments of the invention. Again with the principle feature that the volume between adjacent screw

threads and the container or housing in which the feed screw is positioned diminishes from vessel 20A to vessel 25A. As seen in Fig. 2, the transfer mechanism 10A has a housing 15A conical in shape and the screw 30 therein may or may not be a progressive pitch screw. The screw threads in the embodiment illustrated in Fig. 2 may not need to be closer together, that is the pitch need not be diminished in order to reduce the volume of the material between adjacent threads and the housing wall as the material is moved from left to right or from vessel 20A to vessel 25A. However, it may be advantageous to use both the conical shaped inner housing 15A with or without a progressive screw 30A depending on engineering considerations.

Referring to Fig. 3, there is shown another embodiment of the present invention in which the shank 31B of the screw 30B is conical in shape with the larger end of the cone being adjacent the vessel 25B and with the pitch between adjacent threads 32B being constant or diminishing. In either case, the volume of the area between adjacent threads and the inner container 15B diminishes as the material is moved from the vessel 20B to the vessel 25B.

Referring to Fig. 4, there is shown a further embodiment 10C of the present invention in which a cylinder 15C interconnects vessels 20C and 25C and transports slurry while concentrating same between the two vessels. Slurry entering the inlet 19C of the cylinder 15C is concentrated upon rotation of screw 30C due to movement of the helical thread 32C upon rotation of the shaft 31C. The outlet end 18C of cylinder 15C is an apertured plate having an effective diameter smaller than the inlet 19C thereby restricting flow of the slurry causing in cooperation with the screw 30C and housing or cylinder 15C the solids in the slurry to concentrate while liquid is expressed from the

slurry and is separated therefrom through outlet or drain 12C. As solids concentrate at the outlet end 18C, a plug is formed which isolates, as hereinbefore explained, vessel 20 from vessel 25, thereby permitting the continuous production of slurry in vessel 20, or a vessel or container in communication therewith, and continuous separation of solids, even if wet with liquid, by the transfer mechanism 10C in vessel 25 or a vessel in communication therewith for further treatment in the same or different environment as vessel 20.

By way of example only, in the production of Ti or a Ti alloy by the reduction of $TiCl_4$ with Na in an inert atmosphere as taught in the incorporated Armstrong patents, separation of Na and/or NaCl from Ti or Ti alloy powder in vessel 25 may be accomplished by distillation and/or by a hot inert sweep gas followed by passivation and/or washing the water. By effectively separating the environments in vessels 20 and 25, continuous operation of production and separation is accomplished, an important commercial feature. In one example of the invention, liquid Na may be present at about 60% by weight of the slurry leaving vessel 20, while the wet solids discharged into vessel 25 may have Na present only in the range of from about 20 to about 50% by weight.

Although the invention has been described with respect to an inerted vessel and a vacuum vessel, the invention includes movement and concentration of material from one container to another without compromising the environment of either container. The containers may be connected pipes or vessels, and the environments may be vacuums, inerted atmospheres or otherwise. Central to the invention is concentration of solids in a slurry to transport solids from one environment to another while forming

a seal or plug therebetween so as to isolate the environments from each other.

While there has been disclosed what is considered to be the preferred embodiment of the present invention, it is understood that various changes in the details may be made without departing from the spirit, or sacrificing any of the advantages of the present invention.

WHAT IS CLAIMED IS:

1. A transfer mechanism between a first vessel containing a slurry of liquid and solids and a second vessel with at least one of said first and second vessels being under a protective atmosphere and/or vacuum, comprising a housing in communication with said first and said second vessels, a screw having at least one helical thread along a longitudinal shank within said housing for transferring material from said first vessel to said second vessel, said screw and said housing cooperating to compress the slurry, whereby slurry entering said housing from said first vessel has the solids therein concentrated as the slurry is transported by said screw toward said second vessel while liquid is expressed from the slurry as the solids are concentrated until the concentrated solids form a plug isolating said second vessel from said first vessel while solids discharge into said second vessel.

2. The transfer mechanism of claim 1, wherein the volume between adjacent screw threads and said housing diminishes between said first and said second vessels.

3. The transfer mechanism of claim 1, wherein said screw is a variable pitch screw.

4. The transfer mechanism of claim 1, wherein said screw is a progressive pitch screw with the smallest pitch being nearest said second vessel.

5. The transfer mechanism of claim 1, wherein said housing is generally cylindrical.

6. The transfer mechanism of claim 1, wherein said housing is conical with the smallest end being nearest said second vessel.

7. The transfer mechanism of claim 1, wherein said housing has an inlet with a first diameter and an outlet with a second diameter near said second vessel, said outlet being smaller than said inlet.

8. The transfer mechanism of claim 1, wherein said housing is cylindrical having the end in communication with said second vessel restricting flow of concentrated solids from said housing to said second vessel.

9. The transfer mechanism of claim 1, wherein said housing near said second vessel has a restriction therein.

10. The transfer mechanism of claim 9, wherein the restriction in said housing is an apertured plate in the end of said housing in communication with said second vessel.

11. The transfer mechanism of claim 1, wherein said housing is cylindrical and said screw is a progressive pitch screw with the smallest pitch being nearest said second vessel.

12. The transfer mechanism of claim 1, wherein said housing is conical with the smallest end being nearest said second vessel and said screw has threads of constant pitch.

13. The transfer mechanism of claim 1, wherein said shank has an increasing diameter toward said second vessel.

14. The transfer mechanism of claim 1, wherein at least a part of said housing in communication with said first vessel has a plurality of apertures therein.

15. The transfer mechanism of claim 14, wherein the plurality of apertures is a mesh.

16. The transfer mechanism of claim 1, and further comprising an outlet in said housing for separating liquid expressed from the slurry from the concentrated solids.

17. A transfer mechanism between a first vessel containing a slurry of liquid alkali or alkaline earth metal or mixtures thereof and metal or alloy or ceramic particles and halide salt particles and a second vessel with at least one of said first and second vessels having a protective atmosphere and/or vacuum therein, comprising a housing in communication with said first and said second vessels, a screw having at least one helical thread along a longitudinal shank within said housing for transferring material from said first vessel to said second vessel, said screw and said housing cooperating to increase the concentration of solids in the slurry between said first and said second vessels until the concentrated particles form a plug isolating said second vessel and the protective atmosphere or vacuum therein from said first vessel and the protective atmosphere or vacuum therein while solids discharge into said second vessel.

18. The transfer mechanism of claim 17, wherein said screw is a progressive pitch screw with the smallest pitch being nearest said second vessel.

19. The transfer mechanism of claim 17, wherein said housing is generally cylindrical.

20. The transfer mechanism of claim 17, wherein said housing is conical with the smallest end being nearest said second vessel.

21. The transfer mechanism of claim 17, wherein said housing is cylindrical and said screw is a progressive pitch screw with the smallest pitch being nearest said second vessel.

22. The transfer mechanism of claim 17, wherein said housing is conical with the smallest end being nearest said second vessel and said screw has threads of constant pitch.

23. The transfer mechanism of claim 17, wherein said shank has an increasing diameter toward said second vessel.

24. The transfer mechanism of claim 17, wherein at least a part of said housing in liquid communication with said first vessel has a plurality of apertures therein.

25. The transfer mechanism of claim 24, wherein the plurality of apertures is a mesh.

26. The transfer mechanism of claim 17, and further comprising an outlet in said housing for separating liquid from the solids in the slurry.

27. The transfer mechanism of claim 26, wherein a double wall housing is provided wherein the inner wall has a portion thereof apertured and a portion thereof solid and the outer wall has said outlet therein, said screw being positioned within said inner wall.

28. The transfer mechanism of claim 17, wherein said housing is cylindrical having the end in communication with said second vessel restricting flow of concentrated solids from said housing to said second vessel.

29. The transfer mechanism of claim 17, wherein said housing near said second vessel has a restriction therein.

30. The transfer mechanism of claim 29, wherein the restriction in said housing is an apertured plate at or near the end of said housing in communication with said second vessel.

31. A method of concentrating and transferring a slurry of a liquid and solids from one container to another while isolating the environments within said containers from each other, comprising providing communication between the containers, transporting slurry from one container toward another container while expressing liquid from the slurry thereby increasing the solids concentration thereof until a plug is formed between two containers isolating the containers while solids from the plug are transferred to the another container.

32. The method of claim 31, wherein at least one container is operated under an inert atmosphere.

33. The method of claim 31, wherein at least one container is operated under vacuum.

34. The method of claim 31, wherein the slurry contains liquid metal and metal particles.

35. The method of claim 34, wherein the slurry contains liquid alkali or alkaline earth metal.

36. The method of claim 34, wherein slurry contains liquid sodium metal and particles of Ti or an alloy thereof.

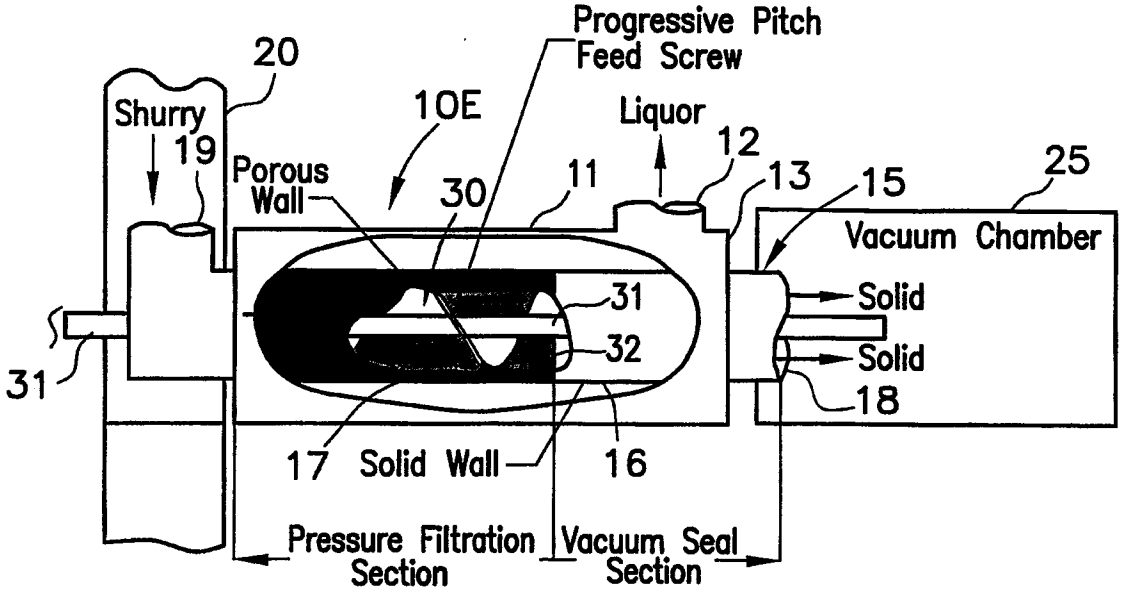
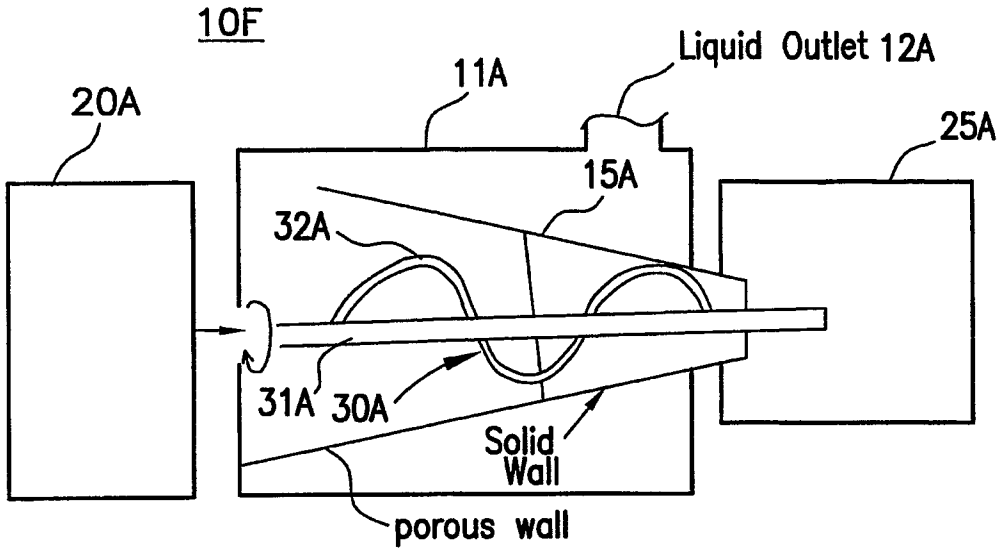

Progressive Pitch
Feed Screw
20
Shurry
19
10E
Liquor
12
Porous
Wall
30
11
13
15
25
Vacuum Chamber
31
Solid
32
Solid
31
18
17
Solid Wall
16
Pressure Filtration
Section
Vacuum Seal
Section

FIG.1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Liquid Outlet 12A
11A
20A
25A
15A
32A
31A
30A
Solid Wall
porous wall

FIG. 2

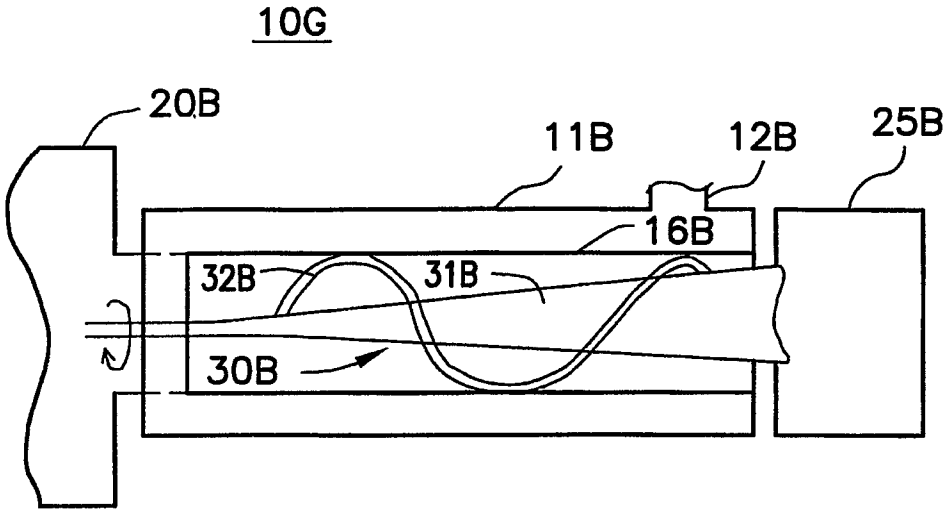
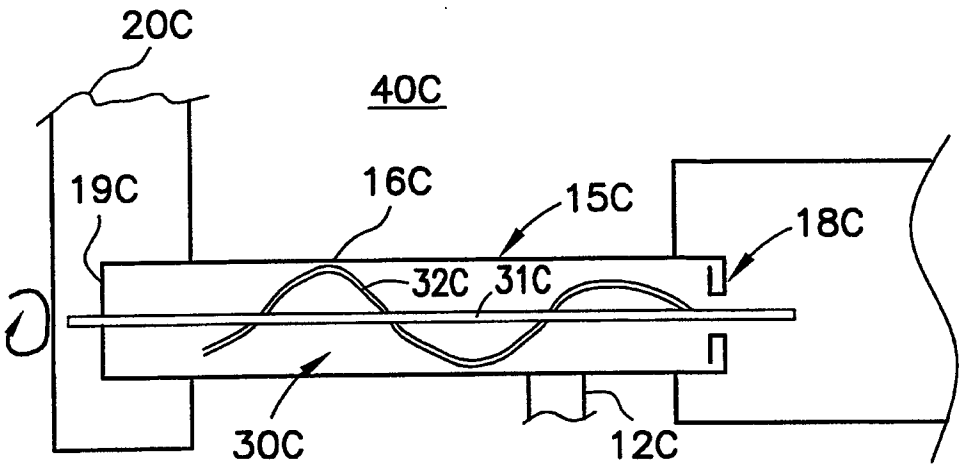


FIG.3



Comparison solids w/o changing volume

FIG.4

INTERNATIONAL SEARCH REPORT

In Application No
PCT/US2004/033823

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C22B34/12 C22B5/04 B30B9/14 B30B9/12 B29C47/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C22B B30B B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y,P		9,10,29, 30
Y	US 4 839 120 A (BABA TOSHIO ET AL) 13 June 1989 (1989-06-13) column 2, line 57 - column 3, line 11; figure 1	1-36
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 January 2005	24/01/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Baumgartner, R

INTERNATIONAL SEARCH REPORT

Ir al Application No
PCT/US2004/033823

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 5 958 106 A (ANDERSON RICHARD PAUL ET AL) 28 September 1999 (1999-09-28) cited in the application column 5, line 66 - column 7, line 23; figures 1,3,4	1,17, 34-36
Y	US 3 836 302 A (KAUKEINEN R) 17 September 1974 (1974-09-17) abstract column 1, line 55 - column 4, line 63 figures 1,2	9,10,29, 30

INTERNATIONAL SEARCH REPORT

nformation on patent family members

In nal Application No
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